IN THE CLAIMS:

Claims 1 – 100 (Cancel)

Claim 101. (Currently Amended) A method for laser induced breakdown (LIB) of a material with a pulsed laser beam, the material being characterized by a relationship of fluence breakdown at which breakdown occurs versus laser pulse width that exhibits a distinct change in slope at a characteristic laser pulse width, said method comprising the steps of:

a. generating at least one laser pulse which has a pulse width equal to or less than said characteristic laser pulse width; and

b. directing said pulse to a point above the surface of the material <u>so that the focus of the beam is not at or beneath the surface of the material.</u>

Claim 102. (Previously Presented) The method according to claim 101, wherein the material is a metal, the pulse width is 10 to 10,000 femtoseconds, and the pulse has an energy of 1 nanojoule to 1 microjoule.

Claim 103. (Previously Presented) The method according to claim 101, wherein the spot size is varied within a range of 1 to 100 microns by changing the of number of the laser beam.

Claim 104. (Previously Presented) The method according to claim 101, wherein the spot size is varied within a range of 1 to 100 microns by varying the target position.

Claim 105. (Previously Presented) The method according to claim 101, wherein the material is transparent to radiation emitted by the laser and the pulse width is 10 to 10,000 femtoseconds, the pulse has an energy of 10 nanojoules to 1 millijoule.

Claim 106. (Previously Presented) The method according to claim 101, wherein the step of focusing directs the focus of the beam to a point above the surface.

Claim 107. (Currently Amended) A method for laser induced breakdown (LIB) of a material with a pulsed laser beam, the material being characterized by a relationship of fluence breakdown threshold versus laser pulse width that exhibits a rapid and distinct change in slope at a predetermined laser pulse width where the onset of plasma induced breakdown occurs, said method comprising the steps of:

a. generating a beam of one or more laser pulses in which each pulse has a pulse width equal to or less than said predetermined laser pulse width obtained by determining the ablation (LIB) threshold of the material as a function of pulse width and by determining where the ablation (LIB) threshold function is no longer proportional to the square root of pulse width; and

b. focusing said beam to a point above the surface of the material so that the ablation threshold of said beam is substantially at said surface <u>so that the focus of the beam is not at or beneath the surface of the material.</u>

Claim 108. (Previously Presented) The method according to claim 101, wherein the laser pulse has an energy in a range of 10 nanojoules to 1 millijoule.

Claim 109. (Previously Presented) The method according to claim 101, wherein the laser pulse has a fluence in a range of 100 millijoules per square centimeter to 100 joules per square centimeter.

Claim 110. (Previously Presented) The method according to claim 101, wherein the laser pulse defines a spot in or on the material and the LIB causes ablation of an area having a size smaller than the area of the spot.

Claim 111. (Previously Presented) The method according to claim 101, wherein the laser pulse has a wavelength in a range of 200 nanometers to 2 microns.

Claim 112. (Previously Presented) The method according to claim 101, wherein the pulse width is in a range of a few picoseconds to femtoseconds.

Claim 113. (Previously Presented) The method according to claim 101, wherein the breakdown includes changes caused by one or more of ionization, free electron multiplication, dielectric breakdown, plasma formation, and vaporization.

Claim 114. (Previously Presented) The method according to claim 101, wherein the breakdown includes plasma formation.

Claim 115. (Previously Presented) The method according to claim 101, wherein the breakdown includes disintegration.

Claim 116. (Previously Presented) The method according to claim 101, wherein the breakdown includes ablation.

Claim 117. (Previously Presented) The method according to claim 101, wherein the breakdown includes vaporization.

Claim 118. (Previously Presented) The method according to claim 101, wherein the spot size is varied by flexible diaphragm to a range of 1 to 100 microns.

Claim 119. (Previously Presented) The method according to claim 101, wherein a mask is placed in the path of the beam to block a portion of the beam to cause the beam to assume a desired geometric configuration.

Claim 120. (Previously Presented) The method according to claim 101, wherein the laser operating mode is non-TEMoo.

Claim 121. (Previously Presented) The method according to claim 101, wherein the lateral profile is a substantially gaussian profile.

Claim 122. (Previously Presented) The method according to claim 121, wherein the spot size is a diffraction limited spot size providing an ablation cavity having a diameter less than the fundamental wavelength size.

Claim 123. (Previously Presented) The method according to claim 101, wherein the characteristic pulse width is obtained by determining the ablation (LIB) threshold of the material as a function of pulse width and determining where the ablation (LIB) threshold function is no longer proportional to the square root of pulse width.

Claim 124. (Currently Amended) A method for laser induced breakdown of a material which comprises:

a. generating a beam of one or more laser pulses in which each pulse has a pulse width equal to or less than a pulse width value corresponding to a change in slope of a curve of fluence breakdown threshold (Fth) as a function of laser pulse width (T), said change occurring at a point between first and second portions of said curve, said first portion spanning a range of relatively long pulse width where Fth varies with the square root of pulse width (T1/2) and said second portion spanning a range of short pulse width relative to said first portion with a Fth versus T slope which differs from that of said first portion; and

b. directing said one or more pulses of said beam to a point above the surface of the material <u>so that the focus of the beam is not at or beneath the surface of the material.</u>

Claim 125. (Previously Presented) The method according to claim 124 and further including:

a. identifying a pulse width start point;

b. directing the laser beam initial start point above the surface of the material; and

c. scanning said beam along a predetermined path in a transverse direction.

Claim 126. (Previously Presented) The method according to claim 124 and further including:

a. identifying a pulse width start point;

b. directing the laser beam initial start point above the surface of the material; and

c. scanning said beam along a predetermined path in a longitudinal direction in the material to a depth smaller than the Rayleigh range.

Claim 127. (Previously Presented) The method according to claim 124, wherein the breakdown includes changes caused by one or more of ionization, free electron multiplication, dielectric breakdown, plasma formation, and vaporization.

Claim 128. (Previously Presented) The method according to claim 124, wherein the breakdown includes plasma formation.

Claim 129. (Previously Presented) The method according to claim 124, wherein the breakdown includes disintegration.

Claim 130. (Previously Presented) The method according to claim 124, wherein the breakdown includes ablation.

Claim 131. (Previously Presented) The method according to claim 124, wherein the breakdown includes vaporization.

Claim 132. (Previously Presented) The method according to any one of claims 101, 102, 105 or 124, wherein said beam is obtained by chirped-pulse amplification (CPA) means comprising means for generating a short optical pulse having a predetermined duration;

means for stretching such optical pulse in time;

means for amplifying such time-stretched optical pulse including solid state amplifying media; and

means for recompressing such amplified pulse to its original duration.

Claim 133. (Currently Amended) A method for laser induced breakdown (LIB) of a material with a pulsed laser beam, the material being characterized by a relationship of fluence threshold at which breakdown occurs versus laser pulse width that exhibits a distinct change in slope at a predetermined laser pulse width where the onset of plasma induced breakdown occurs, said method comprising the steps of:

a. generating at least one laser pulse which has a pulse width equal to or less than said predetermined laser pulse width; and

b. directing said pulse to a point above the surface of the material so that the laser beam defines a spot and has a lateral profile characterized in that fluence at or near the center of the beam spot is greater than the threshold fluence whereby the laser induced breakdown is ablation of an area within the spot <u>so that the focus of the beam is not at or beneath the surface of the material.</u>

Claim 134. (Previously Presented) The method according to claim 133, wherein the spot size is a diffraction limited spot size providing an ablation cavity having a diameter less than the fundamental wavelength size.

Claim 135. (Previously Presented) A method for laser induced breakdown (LIB) of a material with a pulsed laser beam, the material being characterized by a relationship of fluence threshold at which breakdown occurs versus laser pulse width that exhibits a distinct change in slope at a predetermined laser pulse width where the onset of plasma induced breakdown occurs, said method comprising the steps of:

a. generating at least one laser pulse which has a pulse width equal to or less than said predetermined laser pulse width;

b. directing said pulse to a point above the surface of the material the pulse width is 10 to 10,000 femtoseconds and the beam has an energy of 10 nanojoules to 1 millijoule; and

c. directing said pulse to a point above the surface of the material so that the laser beam defines a spot and has a lateral profile characterized in that fluence at or near the center of the beam spot is greater than the threshold fluence whereby the laser induced breakdown is ablation of an area within the spot.

Claim 136. (Currently Amended) A method for laser induced breakdown (LIB) of a material by plasma formation with a pulsed laser beam, the material being characterized by a relationship of fluence threshold at which breakdown occurs versus laser pulse width that exhibits a distinct change in slope at a characteristic laser pulse width, said method comprising the steps of:

a. generating at least one laser pulse which has a pulse width equal to or less than said characteristic laser pulse width, said characteristic pulse width being defined by the

ablation (LIB) threshold of the material as a function of pulse width where the ablation (LIB) threshold function is no longer proportional to the square root of pulse width; and

b. directing said pulse to a point above the surface of the material and inducing breakdown by plasma formation in the material <u>so that the focus of the beam is not at or beneath the surface of the material.</u>

Claim 137. (Currently Amended) A method for laser induced breakdown of a material which comprises:

a. determining, for a selected material, characteristic curve of fluence breakdown threshold (Fth) as a function of the square root of laser pulse width;

b. identifying a pulse width value on said curve corresponding to a distinct change in the relationship between the fluence breakdown and the square root of pulse width characteristic of said material;

c. generating a beam of one or more laser pulses, said pulses having a pulse width at or below said pulse width value corresponding to said distinct change in slope; and

d. directing said one or more pulses of said beam to a point above the surface of the material <u>so that the focus of the beam is not at or beneath the surface of the material.</u>

Claim 138. (Previously Presented) The method according to claim 137 and further including:

a. identifying a pulse width start point;

b. directing the laser beam initial start point above the surface of the material; and

c. scanning said beam along a predetermined path in a transverse direction.

Claim 139. (Previously Presented) The method according to claim 137 and further including:

a. identifying a pulse width start point;

b. directing the laser beam initial start point above the surface of the material; and

c. scanning said beam along a predetermined path in a longitudinal direction in the material to a depth smaller than the Rayleigh range.

Claim 140. (Previously Presented) The method according to claim 137, wherein the breakdown includes changes caused by one or more of ionization, free electron multiplication, dielectric breakdown, plasma formation, and vaporization.

Claim 141. (Previously Presented) The method according to claim 137, wherein the breakdown includes plasma formation.

Claim 142. (Previously Presented) The method according to claim 137, wherein the breakdown includes disintegration.

Claim 143. (Previously Presented) The method according to claim 137, wherein the breakdown includes ablation.

Claim 144. (Previously Presented) The method according to claim 137, wherein breakdown includes vaporization.

Claim 145. (Previously Presented) The method according to any one of claims 135 or 137, wherein said beam is obtained by chirped-pulse amplification (CPA) means comprising means for generating a short optical pulse having a predetermined duration;

means for stretching such optical pulse in time;

means for amplifying such time-stretched optical pulse including solid state amplifying media;

and means for recompressing such amplified pulse to its original duration.

Claim 146. (Currently Amended) A method for laser induced breakdown (LIB) of a metallic material with a pulsed laser beam, the material being characterized by a relationship of fluence threshold at which breakdown occurs versus laser pulse width that exhibits a distinct change in slope at a characteristic laser pulse width, said method comprising the steps of:

generating at least one laser pulse which has a pulse width equal to or less than said characteristic laser pulse width, said pulse having a width between 10 and 10,000 femtoseconds, and the pulse has an energy of 1 nanojoule to 1 microjoule; and

directing the pulse to a point above the surface of the material <u>so that the focus of the beam is not at or beneath the surface of the material.</u>

Claim 147. (Previously Presented) A method as in claim 146, wherein said beam is obtained by chirped pulse amplification (CPA) means comprising means for generating a short optical pulse having a predetermined duration;

means for stretching such optical pulse in time;

means for amplifying such stretched optical pulse including solid state amplifying media; and

means for recompressing such amplified pulse to its original duration.

Claim 148. (Currently Amended) A method for laser induced breakdown (LIB) of a metallic material transparent to radiation with a pulsed laser beam, the material being characterized by a relationship of fluence threshold at which breakdown occurs versus laser pulse width that exhibits a distinct change in slope at a characteristic laser pulse width, said method comprising the steps of:

generating at least one laser pulse which has a pulse width equal to or less than said characteristic laser pulse width, where the laser pulse width is 10 to 10,000 femtoseconds and the laser pulse has an energy of 10 nanojoules to 1 millijoule; and

directing the pulse to a point above the surface of the material <u>so that the focus of the beam is not at or beneath the surface of the material.</u>

Claim 149. (Previously Presented) A method as in claim 148, wherein said beam is obtained by chirped pulse amplification (CPA) means comprising means for generating a short optical pulse having a predetermined duration;

means for stretching such optical pulse in time;

means for amplifying such stretched optical pulse including solid state amplifying media; and

means for recompressing such amplified pulse to its original duration.

Claim 150. (Currently Amended) A method for laser induced breakdown (LIB) of a metallic material with a pulsed laser beam, the material being characterized by a relationship of fluence threshold at which breakdown occurs versus the square root of laser pulse width that exhibits a distinct change in slope at a characteristic laser pulse width;

determining the ablation (LIB) threshold of the material as a function of pulse width and determining where the ablation (LIB) threshold function is no longer proportional to the square root of pulse width;

generating at least one laser pulse which has a pulse width equal to or less than the characteristic pulse width; and

directing the pulse to a point above the surface of the material <u>so that the focus of the beam is not at or beneath the surface of the material.</u>

Claim 151. (Currently Amended) A method of optimally selecting a pulse width and fluence for a pulsed laser beam such that the pulsed laser induces laser induced breakdown (LIB) of a material, the material being characterized by a relationship of fluence threshold at which breakdown occurs versus the square root of laser pulse width comprising the step of identifying where the relationship between fluence threshold and the square root of pulse width exhibits a distinct change in slope and selecting the pulse width and fluence level associated with the distinct change in slope and directing the pulse at a point above the surface of the material <u>so that the focus of the beam is not at or beneath the surface of the material.</u>

Claim 152. (Previously Presented) The method as in claim 151, wherein the material is non-organic.

Claim 153. (Previously Presented) A method as in claim 151, wherein the material is organic.

Claim 154. (Currently Amended) A method for laser induced breakdown of a material with a pulsed laser beam, the material being characterized by a relationship of fluence threshold at which breakdown occurs versus the square root of laser pulse width that exhibits a distinct change in slope at a characteristic pulse width, said method comprising the steps of:

selecting a pulse width and fluence which is equal to or less than the distinct change in slope;

generating at least one laser pulse which has a pulse width equal to or less than the characteristic laser pulse width and fluence; and

directing said pulse to a point above the surface of a material <u>so that the focus of the beam is not at or beneath the surface of the material.</u>

Claim 155. (Previously Presented) The method according to claim 124, wherein the step of focusing directs the focus of the beam to a point above the surface.

Claim 156. (Previously Presented) The method according to claim 133, wherein the step of focusing directs the focus of the beam to a point above the surface.

Claim 157. (Previously Presented) The method according to claim 135, wherein the step of focusing directs the focus of the beam to a point above the surface.

Claim 158. (Previously Presented) The method according to claim 136, wherein the step of focusing directs the focus of the beam to a point above the surface.

Claim 159. (Previously Presented) The method according to claim 137, wherein the step of focusing directs the focus of the beam to a point above the surface.

Claim 160. (Previously Presented) The method according to claim 146, wherein the step of focusing directs the focus of the beam to a point above the surface.

Claim 161. (Previously Presented) The method according to claim 148, wherein the step of focusing directs the focus of the beam to a point above the surface.

Claim 162. (Previously Presented) The method according to claim 150, wherein the step of focusing directs the focus of the beam to a point above the surface.

Claim 163. (Previously Presented) The method according to claim 151, wherein the step of focusing directs the focus of the beam to a point above the surface.

Claim 164. (Previously Presented) The method according to claim 154, wherein the step of focusing directs the focus of the beam to a point above the surface.

Claim 165. (Previously Presented) The method according to claim 124, wherein the step of directing the pulse at a point above the surface of the material maintains the ablation threshold substantially at the surface of the material.

Claim 166. (Previously Presented) The method according to claim 133, wherein the step of directing the pulse at a point above the surface of the material maintains the ablation threshold substantially at the surface of the material.

Claim 167. (Previously Presented) The method according to claim 135, wherein the step of directing the pulse at a point above the surface of the material maintains the ablation threshold substantially at the surface of the material.

Claim 168. (Previously Presented) The method according to claim 136, wherein the step of directing the pulse at a point above the surface of the material maintains the ablation threshold substantially at the surface of the material.

Claim 169. (Previously Presented) The method according to claim 137, wherein the step of directing the pulse at a point above the surface of the material maintains the ablation threshold substantially at the surface of the material.

Claim 170. (Previously Presented) The method according to claim 146, wherein the step of directing the pulse at a point above the surface of the material maintains the ablation threshold substantially at the surface of the material.

Claim 171. (Previously Presented) The method according to claim 148, wherein the step of directing the pulse at a point above the surface of the material maintains the ablation threshold substantially at the surface of the material.

Claim 172. (Previously Presented) The method according to claim 150, wherein the step of directing the pulse at a point above the surface of the material maintains the ablation threshold substantially at the surface of the material.

Claim 173. (Previously Presented) The method according to claim 151, wherein the step of directing the pulse at a point above the surface of the material maintains the ablation threshold substantially at the surface of the material.

Claim 174. (Previously Presented) The method according to claim 154, wherein the step of directing the pulse at a point above the surface of the material maintains the ablation threshold substantially at the surface of the material.

Claim 175. (Previously Presented) The method according to claim 155, further including adjusting the intensity of the beam to the minimum necessary for ablation.

Claim 176. (Previously Presented) The method according to claim 156, further including adjusting the intensity of the beam to the minimum necessary for ablation.

Claim 177. (Previously Presented) The method according to claim 157, further including adjusting the
intensity of the beam to the minimum necessary for ablation.

Claim 178. (Previously Presented) The method according to claim 158, further including adjusting the intensity of the beam to the minimum necessary for ablation.

Claim 179. (Previously Presented) The method according to claim 159, further including adjusting the intensity of the beam to the minimum necessary for ablation.

Claim 180. (Previously Presented) The method according to claim 160, further including adjusting the intensity of the beam to the minimum necessary for ablation.

Claim 181. (Previously Presented) The method according to claim 161, further including adjusting the intensity of the beam to the minimum necessary for ablation.

Claim 182. (Previously Presented) The method according to claim 162, further including adjusting the intensity of the beam to the minimum necessary for ablation.

Claim 183. (Previously Presented) The method according to claim 163, further including adjusting the intensity of the beam to the minimum necessary for ablation.

Claim 184. (Previously Presented) The method according to claim 164, further including adjusting the intensity of the beam to the minimum necessary for ablation.

Claim 185. (Previously Presented) The method according to claim 101 wherein said material is a biologic material.

Claim 186. (Previously Presented) The method according to claim 101 wherein said material is a non-biologic material.

Claim 187. (Previously Presented) The method according to claim 135 wherein said material is a biologic material.

Claim 188. (Previously Presented) The method according to claim 135 wherein said material is a non-biologic material.

Claim 189 (Previously Presented) The method according to claim 121 where in the lateral profile is a substantially Gaussian profile.

Claim 190 (Previously Presented) The method according to claim 124 where in the lateral profile is a substantially Gaussian profile.

Claim 191 (Previously Presented) The method according to claim 135 where in the lateral profile is a substantially Gaussian profile.

Claim 192 (Previously Presented) The method according to claim 136 where in the lateral profile is a substantially Gaussian profile.

Claim 193 (Previously Presented) The method according to claim 137 where in the lateral profile is a substantially Gaussian profile.

Claim 194 (Previously Presented) The method according to claim 146 where in the lateral profile is a substantially Gaussian profile.

Claim 195 (Previously Presented) The method according to claim 148 where in the lateral profile is a substantially Gaussian profile.

Claim 196 (Previously Presented) The method according to claim 150 where in the lateral profile is a substantially Gaussian profile.

Claim 197 (Previously Presented) The method according to claim 151 where in the lateral profile is a substantially Gaussian profile.

Claim 198 (Previously Presented) The method according to claim 156 where in the lateral profile is a substantially Gaussian profile.

Claim 199. (Added) A method according to any of claims 101, 107, 124, 133, 136, 137, 146, 148, 150, 151 or 154 wherein the laser beam defines a spot and has a lateral profile characterized in that fluence at or near the center of the beam spot is greater than the threshold fluence whereby the laser induced breakdown is ablation of an area within the spot.

Claim 200. (Added) The method according to claim 99 where in the lateral profile is a substantially Gaussian profile.

Claim 201. (Added) A method according to any one of claims 101, 107, 124, 133, 136, 137, 146, 148, 150, 151 or 154 wherein said ablation threshold of the beam is at or beneath the surface of the material.